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ABSTRACT

The effects of imagery instructions, word arousal value, and retention interval on children's literal and inferential comprehension of text was studied using 459 grade 3, 4 and 5 students. Imagery instructions significantly facilitated inferential comprehension on the short-term retention test but this effect disappeared a week later. On the other hand, imagery instructions significantly impaired long-term literal comprehension. Thus the only factor found to significantly enhance long-term comprehension of text was the (positive) arousal manipulation. (Author/SW)

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Technical Report No. 266

CHILDREN'S LEARNING FROM DISCOURSE: AROUSAL AND IMAGERY EFFECTS ON LITERAL AND INFERENTIAL COMPREHENSION

by

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Report from the Project on Motivation and
Individual Differences in Learning and Retention

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Statement of Focus

Individually Guided Education (IGE) is a new comprehensive system of elementary education. The following components of the IGE system are in varying stages of development and implementation: a new organization for instruction and related administrative arrangements; a model of instructional programing for the individual student; and curriculum components in prereading, reading, mathematics, motivation, and environmental education. The development of other curriculum components, of a system for managing instruction by computer, and of instructional strategies is needed to complete the system. Continuing programmatic research is required to provide a sound knowledge base for the components under development and for improved second generation components. Finally, systematic implementation is essential so that the products will function properly in the IGE schools.

The Center plans and carries out the research, development, and implementation components of its IGE program in this sequence: (1) identify the needs and delimit the component problem area; (2) assess the possible constraints—financial resources and availability of staff; (3) formulate general plans and specific procedures for solving the problems; (4) secure and allocate human and material resources to carry out the plans; (5) provide for effective communication among personnel and efficient management of activities and resources; and (6) evaluate the effectiveness of each activity and its contribution to the total program and correct any difficulties through feedback mechanisms and appropriate management techniques.

A self-renewing system of elementary education is projected in each participating elementary school, i.e., one which is less dependent on external sources for direction and is more responsive to the needs of the children attending each particular school. In the IGE schools, Center-developed and other curriculum products compatible with the Center's instructional programing model will lead to higher student achievement and self-direction in learning and in conduct and also to higher morale and job satisfaction among educational personnel. Each developmental product makes its unique contribution to IGE as it is implemented in the schools. The various research components add to the knowledge of Center practitioners, developers, and theorists.

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Table of Contents

	List of Tables	vii
	Abstract	ix
I.	Introduction	1
II.	Method	5
	Subjects	5
	Materials	5
	Procedure	5
III.	Results	7
IV.	Discussion	9
	References	11

List of Tables

Table		Page
1	Mean Retention Scores for the Various Conditions of the Experiment	7
2	Mean Retention Scores as a Function of Imagery Instructions	7
3	Mean Retention Scores as a Function of Arousal Category	8
4	Summary of Analysis of Variance of the Literal and Inferential Comprehension Scores for the Immediate (1) and Long-term (2) Retention Tests in the Various Groups	8

Abstract

The effects of imagery instructions, word arousal value and retention interval on children's literal and inferential comprehension of text was studied using 459 grade 3, 4 and 5 students.

Imagery instructions significantly facilitated inferential comprehension on the short-term retention test but this effect disappeared a week later. On the other hand, imagery instructions significantly impaired long-term literal comprehension.

Word arousal (positive affect) significantly facilitated long-term literal comprehension.

Thus the only factor found to signficantly enhance long-term comprehension of text was the (positive) arousal manipulation.

Implications of the results for reading research were considered.

I
Introduction

The relationship of arousal to verbal list learning in short- and long-term retention paradigms has been demonstrated in a number of studies (Farley, in preparation). If arousal is monitored physiologically and arousal changes are time-locked to individual item presentations, the general finding has been that high arousal at stimulus presentation leads to poor immediate but superior long-term retention relative to retention data associated with low arousal at stimulus presentation. One powerful aspect of such research has been in the operationalization of motivation as arousal and in relatively clear delineation of motivational variance in verbal learning. The situation concerning arousal and memory is less clear, however, when arousal is experimentally manipulated by nontask variables such as centrally-active stimulant drugs, white auditory noise, and so on. Although the results are generally in line with those noted above, moderating effects of task variables (Haveman & Farley, 1969) and some negative results (Berlyne, Borsa, Hamacher & Koenig, 1966) have been reported. It should be noted that the negative results in the latter study may be due to design considerations (Farley, in preparation). When arousal is treated as an individual differences variable, with Ss initially being stratified on a measure of individual differences in arousal (Farley, Osborne, & Severson, 1970) and subsequently tested in list-learning paradigms with short- and long-term retention intervals (Farley & Gilbert, 1970; Osborne & Farley, 1971), the interaction of arousal and retention interval described above is usually obtained. A model that is capable of handling most of the foregoing data describes memory storage and the transfer from short- to long-term store as functionally related to physiological arousal levels with more efficient transfer at higher levels of arousal but with poorer readout from short-term store during such high levels of physiological and/or biochemical activity.

In the more complex and naturalistic problem of children's reading and processing of organized and connected verbal information, the role of arousal-attention processes are less well known. Some systematic research has been started (Farley, 1972, in preparation; Farley & Eischens, 1972; Farley & Schmuller, in press). The results thus far suggest that the arousal by retention interval interaction often found in verbal list-learning is less descriptive of prose learning. This seems to be so whether putative arousal manipulations are undertaken or arousal is treated as an individual differences variable. Continuous on-line real-time physiological monitoring of arousal during a prose learning task, with physiological responses time-locked to the S's processing of discrete units within text, has not yet been undertaken. When arousal effects in prose are found, they generally are facilitative of both short- and long-term retention test performance. One reason may be that short-term memory has not actually been measured in the studies reported. That is, given the amount of verbal material and the temporal units employed, all retention measures may have reflected long-term memory performance.

Where theory is concerned, any role of arousal in learning from discourse may be attributable to arousal facilitation of long-term retention through influences on transfer or consolidation processes. Another hypothesis would hold that arousal acted through directing, controlling, or otherwise influencing attention during reading. Present data bearing on these viewpoints are insufficient.

One of the most powerful factors facilitating acquisition in list-learning paradigms is mental imagery (Paivio, 1971). However, the contribution of imagery to children's learning is little known when learning is

more complex than the acquisition in one form or another of word lists. How, for instance, might imagery contribute to learning from discourse, to thought initiated by discourse? One likely way is through processes of reification or hypostatization (Davidson, 1971), that is, through rendering the abstract concrete. Operationally, imagery processes in learning from discourse can be studied through instructional manipulations, pictorial versus verbal or printed representations of the material, elaboration, and so on.

It has been hypothesized that central arousal or activational changes may contribute to at least some of the learning and memory effects of imagery (Farley, 1970). Using pupillary response, a relatively well-validated measure of arousal (Nunnally, Knott, Duchnowski, & Parker 1967), there is evidence that the pupil dilates more and takes longer to reach maximum size in an imaging task with abstract than with concrete words as stimuli. This may be interpreted as due to the greater difficulty of forming images to the abstract than to the concrete stimulus, based on evidence that the pupil dilates more when a cognitive task is difficult than when it is simple (Beatty & Kahneman, 1966). This, of course, assumes some comparable central metric or process for "difficulty" between imaging and other task manipulations and instructions held to alter task difficulty. At any rate, learning superiority attributable to stimulus concreteness may be in part due to high arousal or "arousal interference" elicited by processing of the abstract term. The best test of such a rough hypothesis would be long-term retention studies. We would predict from an arousal-memory consolidation view that the best long-term retention would be associated with stimulus abstractness rather than concreteness during learning. The same prediction would be made from Battig's (1972) analysis of the facilitating effects on long-term retention of high task difficulty or intratask interference during original learning. (Parenthetically, it is here hypothesized that the facilitating effects reported by Battig are attributable to high arousal elicited during learning by task difficulty or intratask interference. We are undertaking tests of our hypothesis by obtaining arousal indices in a typical Battig task situation, as well as manipulating arousal independently of the task.) Supportive of the arousal, abstractness, and retention-interval prediction advanced above, Butter (1970) found that the concreteness effect reverses on a long-term retention test, but Yuille (1971) did not obtain this result. Clearly the final word on such an hypothesized reversal is not in. We are presently pursuing it.

Colman and Paivio (1970) have reported that in a paired-associate task a control condition relative to either an imagery-instruction condition or a verbal-mediation condition led to greater pupil dilation, suggesting to the authors that these Ss were finding the task more difficult than were the imagery or verbal-mediation Ss. Thus, the effect of imagery or verbal-mediation instructions might be argued to be that of making the task easier. Interestingly, however, the performance differences between the various groups disappeared by the fourth trial, although the pupillary differences remained. In fact, the pupillary differences were greater late than early in practice. From our arousal-memory consolidation position, it might be suggested that the higher arousal of the control group would lead to better long-term retention relative to the instructed groups. Again, we would make the same prediction from the Battig hypothesis discussed above. The fact that the control group achieved comparable performance levels to the instructed groups suggests that the instructed groups achieved more quickly. The control group, finding the task somewhat more difficult, worked harder to meet the implied demands of the learning situation. By working harder, activation levels were increased, leading to relatively poor short-term memory performance in line with an arousal-memory consolidation hypothesis, but relatively good long-term memory as reflected in later-trial performance. Again, a very long-term retention test is crucial, at a minimum, in sorting out these various interpretations. Arousal may have primarily long-term facilitating effects, while imagery may have primarily short-term effects!

Returning to considerations of arousal, imagery, and children's learning from discourse, it might be hypothesized that imagery should have a relational organizing effect in prose. This point is suggested by the putative parallel processing quality of the imaginal system, in which visual images are apparently organized spatially so that components can be processed synchronously. Thus, imagery instructions in a prose context might be expected to aid S's comprehension of relationships among the units of the passage. This would be expected to be particularly strong where interactive imagery was employed. Elaborating the passage might also facilitate a S's specification of such relationships. From this view, imagery instructions should have a main facilitating effect on prose learning, but particularly on test items involving comprehension of relationships among parts of the passage. Where arousal effects are concerned, our previous work, noted above, would lead to the expectation that arousal manipulations would facilitate

both short- and long-term retention—certainly the latter. A lack of short-term effects might be due to the presence in the task of both short- and long-term memory processing with the effects of arousal facilitation (long-term) and inhibition (short-term) cancelling themselves out. Although we earlier suggested possible activation and imagery relationships in task situations where reasonable estimates of short- versus long-term memory could be obtained, as was also noted earlier, making such distinctions is difficult enough in discourse to inhibit at this time any speculation about possible arousal and imagery relationships in such a context.

The approaches one might take to studying arousal and imagery in discourse are many. One might study instructional effects on the processing of single sentences, passages, or pictorial versus printed material, experimentally contrived or au naturel in vivo material, perhaps with ongoing tracking of CNS activation or peripheral response systems. One could manipulate single-sentence attributes along a concrete-abstract dimension and arousal-affect dimension, and so on. Measures of individual differences in arousal, imagery ability, and perhaps reading ability could be included in an aptitude by treatment interaction design.

The present study investigated imagery instructions on passages analogous to children's readers, with arousal manipulations due to the presence or absence of differentially-arousing words within the passages, and with short- and long-term retention tests of literal and inferential comprehension.

II
Method

Subjects

The subjects were 459 Grade 3, 4, and 5 students from a town adjoining the suburbs of a large midwestern city of 800,000 population. The community was very predominantly white middle-class.

Materials

The prose passage used was 230 words in length and was the same as that employed by Farley and Schmuller (in press). Within the passage, every 21st word was an "arousal event," i.e., it varied as to arousal properties (high positive, high negative, and low). There were ten such words or arousal events in the passage. These words were taken from the Di Vesta and Walls (1970) list in which fifth graders comparable to the present Ss rated 487 words on a number of semantic dimensions. Dimensions of friendly-unfriendly, good-bad, and nice-awful scaled from 1 to 7 points were used in constructing the present word lists. Words rated between 1.00 and 2.60 on two out of three dimensions were used as high-arousal (positive emotionality) words, words rated between 3.5 and 4.5 on two out of three dimensions were used as low-arousal (neutral emotionality) words, and words rated between 5.4 and 7.00 on two out of three dimensions were used as high-arousal (negative emotionality) words. Thus, the high positive- and high negative-arousal words were extreme on the rating scales used, while the low-arousal words were neutral. The high positive-, high negative-, and low-arousal word lists were equated with respect to such major verbal learning variables as Thorndike-Lorge frequency, but had nonoverlapping distributions on the "arousal" dimension. In addition to the foregoing, the passage with the ten high-arousal positive words, the passage with the ten high-arousal negative words, and the passage with the ten low-arousal neutral words were equated by cloze procedure such that on a comparable pilot sample of children it was found that with every 21st word missing, the probability of guessing a high-arousal word (positive or negative) or a low-arousal word at each location were equal. Thus, within the context of the passage used, the probabilities of occurrence of the high positive-, high negative-, and low-arousal words, by cloze technique, were equivalent. The low-arousal words were: slow, hunter, door, tobacco, habit, thirsty, nail, boss, esteem, backward. The high-arousal positive words were: gentle, priest, light, lamb, practice, strong, flower, head, approval, generous. The high-arousal negative words were: bad, robber, noise, slavery, crime, mean, lion, thief, jealousy, ignorant. The passage concerned a fictitious primitive tribe (the Wahoos) in a fictitious country (South Langu) and was written at an age-appropriate reading level.

The employment of arousal words in the passages as described above represented the task manipulation of arousal. The imagery instructions consisted simply of one sentence preceding the passage requesting, "As you are reading the story, try to form pictures in your head of the things and events in the story."

The retention test was multiple-choice, and consisted of ten literal or factual comprehension items and ten inferential items. The order of items in the questionnaire was random.

Procedure

A 2 x 2 x 3 design was used consisting of two instruction conditions (imagery versus no-imagery), two retention intervals (immediate and one week) and three text arousal conditions (high positive, high negative, and low arousal or neutral). Subjects were not instructed that they would be tested on the passage. In line with our previous research (Farley & Schmuller, in press) using the same passages, five minutes

were allowed for reading the passage, although the Ss were not informed of the time limit (which was monitored covertly by E). Eight minutes were allowed for completion of the comprehension test. The one-week test was given at the same time of day and in the same room as the original session. Ss were randomly assigned, within classrooms, to experimental conditions.

III
Results

The mean retention scores for the various conditions are found in Table 1.

The means reported in Table 1, collapsed across arousal conditions, are found in Table 2.

The means reported in Table 1, collapsed across imagery instruction conditions, are found in Table 3.

The foregoing data were subjected to analyses of variance. A summary of the results of this analysis is found in Table 4.

From Table 4 it is apparent that imagery instructions significantly facilitated inferential comprehension on the immediate test, but this effect disappeared on the long-term test. In addition, imagery instructions had a negative effect on literal retention from immediate to long-term tests. That is, although literal comprehension was not affected on the immediate test by imagery instructions, the amount of memory loss on the literal test over the long-term retention interval was increased by imagery instructions relative to control instructions. Finally, high arousal (positive) significantly facilitated long-term literal comprehension relative to high arousal (negative) or low arousal.

TABLE 1
MEAN RETENTION SCORES FOR THE VARIOUS CONDITIONS OF THE EXPERIMENT

Experimental Condition		Retention Interval and Type of Comprehension Test			
		Immediate		One week	
	N	Literal	Inferential	Literal	Inferential
Imagery instructions, high (positive) arousal	76	7.329	5.197	6.526	4.500
Imagery instructions, high (negative) arousal	76	6.803	5.842	5.947	4.816
Imagery instructions, low (neutral) arousal	80	6.800	5.213	5.975	4.825
Control instructions, high (positive) arousal	73	6.945	4.890	6.726	4.384
Control instructions, high (negative) arousal	78	6.885	4.974	6.359	4.603
Control instructions, low (neutral) arousal	76	6.829	4.947	6.421	4.816

TABLE 2
MEAN RETENTION SCORES AS A FUNCTION OF IMAGERY INSTRUCTIONS

Instructional Condition		Retention Interval and Type of Comprehension Test			
		Immediate		One week	
	N	Literal	Inferential	Literal	Inferential
Imagery instructions	232	6.974	5.414	6.147	4.716
Control instructions	227	6.886	4.938	6.498	4.604

TABLE 3
MEAN RETENTION SCORES AS A FUNCTION OF AROUSAL CATEGORY

Arousal Condition	N	Retention Interval and Type of Comprehension Test			
		Immediate		One week	
		Literal	Inferential	Literal	Inferential
High arousal (positive)	149	7.141	5.047	6.624	4.443
High arousal (negative)	154	6.844	5.403	6.156	4.708
Low arousal (neutral)	156	6.814	5.083	6.192	4.821

TABLE 4
SUMMARY OF ANALYSIS OF VARIANCE OF THE LITERAL AND INFERENTIAL COMPREHENSION SCORES FOR THE IMMEDIATE (1) AND LONG-TERM (2) RETENTION TESTS IN THE VARIOUS GROUPS

Source	df	p of multivariate F	p of univariate F[a]			
			Literal 1	Literal 2	Inferential 1	Inferential 2
Imagery	4,566	.019	.760	.105	<u>.051</u>	.796
Arousal	8,1132	.002	.292	<u>.047</u>	.094	.341
linear	4,566	.004	.572	.069	.086	.182
quadratic	4,566	.056				
Imagery x Arousal	8,1132	.819				

Source	df	p of multivariate F	p of univariate F	
			Literal between 1 and 2	Inferential between 1 and 2
Imagery	2,568	.035	<u>.014</u>	.111
Arousal	4,1136	.067		
linear	2,568	.185		
quadratic	2,568	.067		
Imagery x Arousal	4,1136	.915		

Source	df	p of multivariate F	p of univariate F	
			Literal summed 1 and 2	Inferential summed 1 and 2
Imagery	2,568	.063		
Arousal	4,1136	.003	.086	.194
linear	2,568	.002	.166	.077
quadratic	2,568	.161		
Imagery x Arousal	4,1136	.445		

[a]Significant p values are underlined.

IV
Discussion

The present results are relatively clear-cut in indicating a significant short- but not long-term effect of visual imagery instructions on inferential comprehension of text. Although the imagery-inference effect does not hold up over one week, it also does not reverse. However, there is a trend toward such a reversal where literal comprehension is concerned. That is, short-term literal comprehension is slightly better in the imagery than nonimagery condition, whereas, on the other hand, long-term literal comprehension is significantly better in the nonimagery over imagery condition. Assuming that literal or factual retention as presently measured is closer to the processes involved in paired-associate learning than is the present inferential measure, then the results are somewhat in line with those reported by Butler (1970), who reported better paired-associate recall for high-imagery paired-associates on an immediate test, but superior recall for low-imagery paired-associates on a long-term test. Altogether, given the debilitating effects of imagery instructions on long-term factual comprehension and the transient or solely short-term facilitating effects on inferential comprehension, the pedagogical use of imagery instructions in children's reading is not reinforced.

Where arousal is concerned, the literal comprehension data are relatively well in accord with expectation and previous research cited in the introduction. However, the contribution of word arousal to literal comprehension can be expanded on the basis of these results to include the generalization that positive high-arousal words have significantly greater long-term effects than either negative high-arousal words or (neutral) low-arousal words. Although word arousal as presently manipulated does not have long-term relational organizing effects on comprehension in reading, it is also clear that imagery instructions as manipulated have no significant long-term effects. It is obvious, however, that where literal comprehension in reading is concerned, (such) arousal manipulations are more efficacious than (such) imagery manipulations. The search must continue for basic process cues and manipulations that will enhance the comprehension of inference and relation in reading. Other arousal and possibly other imagery manipulations should be pursued.

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